# Plasma-Assisted Active Combustion Control as an Enabling Technology for N+3 Combustors, Phase I

Completed Technology Project (2018 - 2019)

## Project Introduction

This proposal will develop a plasma-assisted modification to a lean direct injected (LDI) combustor to control combustion instabilities and enable clean, compact combustion. Controlling combustion dynamics in jet engine combustors continues to be a major challenge especially in advanced engine designs where, due to leaner flames, less cooling air and more turbulent injectors, there is a higher potential for damaging combustion dynamics.turbine. Various active combustion control methods have been demonstrated for improving combustion stability in jet engines but they have not found wide-spread commercial use.

Moreover, plasma has been shown to be a promising tool for improving flame stabilization. The rapid actuation time and authority of plasma discharges also make plasma an attractive actuator for active combustion control. Plasma can both improve both static stability via kinetic enhancement of reaction pathways and dynamic stability, especially if configured in a closed-loop configuration. Plasmas have already been demonstrated in literature to have positive effects on combustion dynamics. However, further work is necessary to understand the dynamics of flame response to plasma’s, particularly at realistic conditions. To this end, this proposal will use explore a novel method of using plasma as an active control actuator in an LDI combustor to enable reduced emissions and operation at conditions which would have otherwise been unstable. This combustor and its control system will be characterized both at atmospheric pressure as well as at high pressure and high temperature conditions representative of idle and sub idle in a modern jet engine. Various optical and acoustic diagnostics will be used to quantify the effectiveness of the plasma-assisted control system. If this work is successful, it will significantly de-risk the technology and enable partnerships with major engine manufacturers to bring this technology to market.

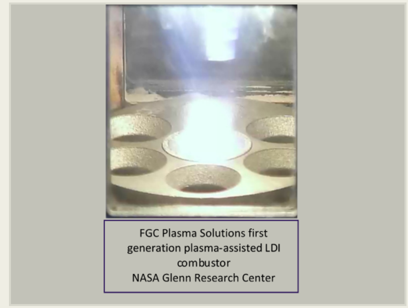
## Anticipated Benefits

The proposed technology can be applied to rocket engines to improve ignition on green propellants and control over combustion dynamics in these systems. This technology also has applications in enabling low emission supersonic transports as well as low NOx, compact, fuel flexible combustors for civil aviation.

In other embodiments, this technology can also be used to improve ignition and combustion stability for scramjet-powered vehicles which may be used for responsive space access.

This technology has significant non-NASA applications as well. The technology is readily applicable to reducing emissions, fuel consumption and engine size for both civil and military jet engines.

The technology can also be applied to gas turbine engines for power

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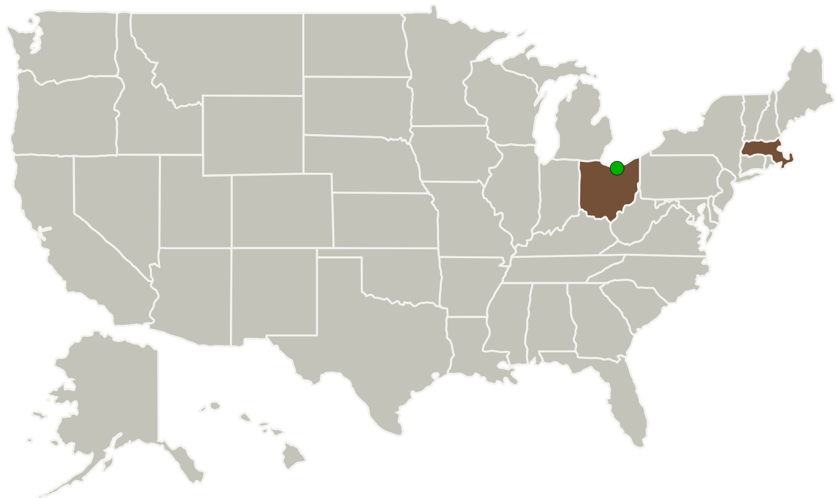
generation to improve fuel flexibility, reduce emisisons and reduce maintinance costs associated with combustion dynamics.

### Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| FGC Plasma Solutions | Lead Organization | Industry<br>Small Disadvantaged Business (SDB) | Lemont, Illinois |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations | |
|---|---|
| Massachusetts | Ohio |

### Project Transitions

**July 2018:** Project Start

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

FGC Plasma Solutions

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

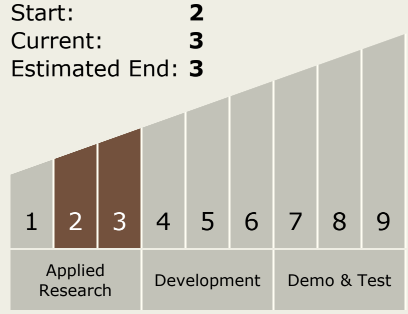
Carlos Torrez

**Principal Investigator:**

Felipe Gomez Del Campo

## Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



**February 2019:** Closed out

**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/137879)*

## Images


**Briefing Chart Image**
Plasma-Assisted Active Combustion Control as an Enabling Technology for N+3 Combustors, Phase I
*(https://techport.nasa.gov/image/134862)*

**Final Summary Chart Image**
Plasma-Assisted Active Combustion Control as an Enabling Technology for N+3 Combustors, Phase I
*(https://techport.nasa.gov/image/126822)*

## Technology Areas

**Primary:**

- TX01 Propulsion Systems
  └ TX01.3 Aero Propulsion
    └ TX01.3.1 Integrated Systems and Ancillary Technologies

## Target Destination

Earth